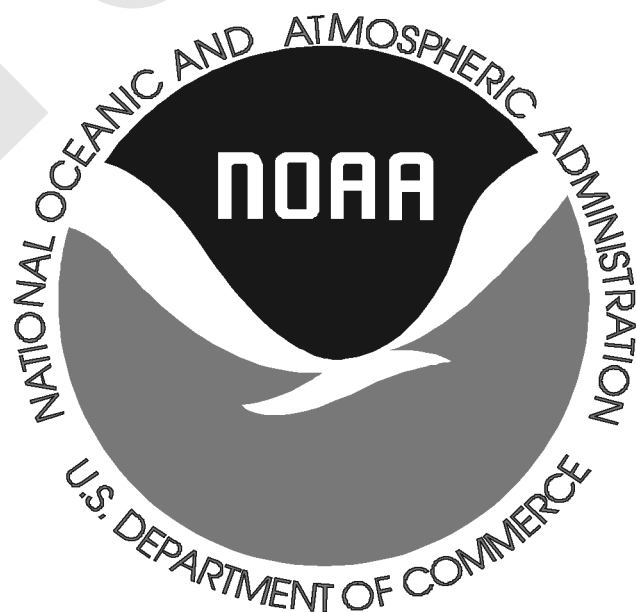


# **Building NOAA's Environmental Real-time Observation Network**

## **Plan Functional Requirements Document**

**May 2006**

**Draft Version 0.6**



**U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
National Weather Service  
National Climatic Data Center**

## **Signature/Approval Page**

### **Building NOAA's Environmental Real-time Observation Network Plan Functional Requirements Document**

**Approved:**

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**Gregory A. Mandt, Director  
Office of Science and Technology**

**Date:** \_\_\_\_\_

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**Tom Karl, Director  
National Climatic Data Center**

**Date:** \_\_\_\_\_

**U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
National Weather Service  
National Climatic Data Center**

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# Functional Requirements for NOAA's Environmental Real-time Observation Network — Baseline Sites

## 1 Purpose

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The National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) is responsible for the operation and maintenance of a nationwide volunteer climate and weather observation network known as the Cooperative Observer Network (COOP). This Plan Functional Requirements Document (PFRD) sets forth the technical requirements of the NWS program to modernize the COOP network as NOAA's Environmental Real-time Observation Network based on the Program Development Plan signed on 31 March 2004 by NWS Director D. L. Johnson. This PFRD has four main objectives:

- Provide sensor and equipment specifications to vendors
- Describe the functions that the data logger must perform
- Describe the functions that the NERON Data Ingest and Processing System must perform
- Provide potential partner mesonets with requirements that must be met to become part of NERON.

### 1.1 System Overview

COOP is the largest and oldest weather and climate-observing network in the world, providing daily weather observations from over 11,500 stations nationwide. It is a unique observation network supported by volunteer observers. The Program Development Plan for COOP Modernization documents the requirements to modernize many of the existing COOP sites and add new sites to achieve the desired network spatial density. All NERON sites will provide five-minute observations in real-time. Baseline stations are stations that automatically report temperature and precipitation data (including human-added elements of liquid equivalent of freezing and frozen precipitation, snowfall, snow depth and, where required, river stage levels). Enhanced stations are those sites where additional sensors have been added due to changing requirements and/or the support of NWS partners. Sections 3 through 26 define the requirements for baseline and enhanced NERON sites.

### 1.2 Vision

The NERON program will maintain the existing baseline measurements, and provide sufficient growth margin to allow for future expansion with additional sensors, resulting in enhanced sites that support a variety of applications. Additional sensors will be deployed as contract options. The system design for baseline sites includes the growth margin for these options, but not for the additional sensors themselves. The site configuration and communications network shall be sized to include these sensors without requiring a redesign. NERON will increase the density of

reporting stations, primarily in the western United States, enhance the suite of deployed sensors, and provide automated real time recording, reporting, and processing capabilities.

### 1.3 Categories of NERON Sites

About 7,500 sites in the continental United States and 500 sites in Alaska and Hawaii will be established during the deployment of NERON. At least 1,000 of the NERON sites are expected to become enhanced sites with additional sensors that meet the requirements of the United States Department of Agriculture. Other NWS partners no doubt will have requirements for additional equipment. Appendix A describes the sensor requirements for enhanced sites. Approximately half of the NERON sites will be selected from existing COOP sites and half the sites will be selected from new locations. The government is responsible for site standards and site selection of NERON sites, which are included in this PFRD. However, on an annual basis, the Government will inform the maintenance contractor(s) of the sites the contractor(s) are responsible for each year.

NERON sites will be drawn from three categories of sites. Category-1 (CAT-1) sites are new sites where observation equipment did not exist. Category-2 (CAT-2) sites are current COOP sites that use legacy equipment. Category-3 (CAT-3) sites, owned or operated by a partner or potential partner of the NWS, are not part of the current COOP network; however, these sites operate at high professional standards, and are candidates for inclusion in NERON. These three categories of sites may or may not have an on-site observer to augment the system information. The Government recognizes that the weather extremes at each location may require equipment configurations to be environmentally robust at a small percentage of locations. The environmental divisions that result are referred to as operating zones. Table 1 provides an estimate of the quantity of baseline sites in each operating zone in the modernization program. The definition of the operating zones is described in Section 20. The Program Development Plan for COOP Modernization describes the implementation strategy.

Table 1. Site categories for the 8000 NERON sites.

	Moderate Weather	Extreme Cold Weather	Extreme Warm Weather	Extreme Cold and Warm
CAT-1 with Observer	~1,550	~300	~50	~100
CAT-1 without Observer	~1,600	~100	~200	~100
CAT-2 with Observer	~3,300	~300	~200	~200
CAT-2 without Observer	0	0	0	0
CAT-3 with Observer	unknown	unknown	unknown	unknown
CAT-3 without Observer	unknown	unknown	unknown	unknown

## 2 Document Overview

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This PFRD sets forth the performance requirements, development, test, integration, and maintenance requirements of NERON.

The requirements for sensor and algorithm performance at a Baseline Site in NERON are listed in Sections 3 through 26. Appendix A lists the performance standards at an Enhanced Site. As a minimum, all modernized sites must meet the sensor and algorithm performance standards for a Baseline Site.

Certain items are listed as goals throughout the document. Goals may be met on a per site basis even though it may not be possible to meet them at all sites. For example, some sites may have communication capabilities, such as GOES or cellular telephones, which may allow certain goals to be met. Another example is the ability to download NERON data via Very High Frequency radio into a nearby state-supported telecommunications network.

The term “To Be Determined” (“TBD”) applied to a requirement means the contractor should determine the missing information in coordination with the Government. The term “To Be Supplied” (“TBS”) means the Government will supply the missing information in the course of the contract. The term “To Be Refined” (“TBR”) means the requirement may be reviewed by the contractor or the Government and may be coordinated with the Government during the course of the contract to improve the overall performance of NERON. The term “Government Furnished Equipment” (GFE) is applied when the Government will supply the equipment or service.

## 3 System Definition

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Baseline sites in NERON will have automated sensors to measure and report temperature and precipitation. The data logger must be expandable to allow for additional sensors defined in Appendix A of this document. Sites with sensors in addition to those elements defined in Sections 3 through 26 are defined as Enhanced Sites in NERON. A requirement exists for the modernized system to provide an ability to augment specified elements by a human observer. The five-minute observations will be formatted in a standardized report and transmitted at least hourly on a single report, or in a series of sequential reports from data collected within the past hour. The goal is to transmit data at intervals of 15 minutes or less.

## 4 Mandatory Elements

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The following are mandatory observations from all baseline sites:

- A. Ambient Air Temperature at 1.5 meters above ground.
- B. Precipitation Accumulation (including freezing/frozen precipitation) at approximately 0.6 to 2.0 meters above ground.

## **5 Functions of the System**

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- A. Observer Augmentation/Annotation,
- B. Data Logging/Processing,
- C. Transmission of Reports, and
- D. Contractor Installation and Maintenance.

## **6 Data Logging/Processing**

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A modern-day data logger is the heart and soul of NERON. The data logger should have a capacity to accept input from no less than twelve sensors. The data logger used in NERON must have the following capabilities:

- A. Storing and processing information.
  - i. The data logger must have memory storage to retain the 5-minute observations from twelve or more sensors for a minimum of 35 days. This storage must be upgradeable through Commercial Off-the-Shelf (COTS) memory or storage modules.
  - ii. The data logger must have built in logic and advanced mathematical functions for processing data. The functions may be in the operating system or hardware.
  - iii. The data logger must be programmable by Government personnel for quality assurance programs, sensor algorithms, sensor sampling frequencies and other programmable needs.
  - iv. The data logger must have a display with at least a 2-inch window and scrollable text or menu selections to enable viewing of sensor data by maintenance technicians.
- B. Interface for sensors at Baseline Sites and Enhanced Sites. The data logger must have channels to accommodate sensors requiring:
  - i. Analog voltage input to a data logger
  - ii. Pulse input to a data logger
  - iii. Digital input to a data logger
  - iv. SDI-12 serial interface to a data logger

- v. RS-232 interface to a data logger. There should be at least two communication ports.
  - vi. Input methods resulting from improvements in sensor technology.
  - vii. The data logger must be upgradeable to allow for additional channel capabilities through a *multiplexer* add-on device. This device should be modular COTS.
  - viii. Input from bio-chemical detection sensors (or a capacity to upgrade to allow input from such sensors).
  - ix. Input from a global positioning system sensor.
  - x. Input for an optional wireless transmitter from the sensor location to an observer's physical location.
- C. The data logger must have an interface for the various methods of transmission of data without loss of data, even when data compression is used. The data logger must:
- i. Be capable of accepting software or hardware upgrades to support the proprietary requirements of various vendors.
  - ii. Be capable of supporting radio links, modem connections, wireless interfaces, GOES Data collection system transmitters, Meteo-burst transmitters, or other communication methods.
  - iii. Support two-way communications.
- D. The data logger time stamps shall be accurate to within  $\pm 1$  minute.
- i. The data logger must have the ability accept remote updates to the clock.
  - ii. Goal: time should be accurate to within  $\pm 5$  seconds after one month.
  - iii. Goal: a global positioning system clock is included in the data logger.
- E. The data logger must have the capability to accept software changes from remote locations.
- F. The data logger must have built in lightning protection.
- G. The data logger software must be able to generate and transmit error messages, diagnostic messages, and alarm messages to facilitate real-time remote fault isolation and recovery.

- H. Although baseline sites in NERON require a 12-channel data logger, the modernized system should have flexibility to allow the contractor to install data loggers with more than 24 channels where required, and when it is not practical to upgrade a 12-channel data logger. Section 26 describes the requirements for reserve resource capacity of the baseline data logger.

## **6.1 Local Archiving of Data**

The data logger must have the ability to store at least 35 days of data. The data logger must have an interface to allow for local retrieval of the data. A technician interfacing through an RS-232 port may execute the retrieval of data or the data may be stored to a removable medium.

## **7 Transmission of Reports**

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The requirement is for hourly transmission of reports. The goal is for reports to be transmitted at least every 15 minutes. The reports may be transmitted from H+01 to H+60. A communications system will automatically transmit the reports in real time in the most cost-effective way. The requirement is for end user receipt of reports 10 minutes after the time of the transmission.

- A. Goal: The goal is for reports to be transmitted at least every 15 minutes and possibly every 5 minutes. Each 15-minute transmission will contain three 5-minute reports and, if applicable, 15 1-minute reports.
- B. The baseline communication system must be independent of any existing host site communication system, but flexible enough to take advantage of existing host site communications where feasible and agreed to by the host site volunteer.
- C. In the case where existing host site communications are used, the host site must not interfere with hardware or software in NERON.
- D. The method of communication chosen for any given interface to transfer data shall minimize the life cycle communication and maintenance costs. There may be one national communication solution or a variety because of local solutions (e.g., GOES DCP, cell phone, DSL, LETS, etc.).
- E. Goal: The system should provide two-way communication to allow remote monitoring for data downloading, data quality assurance, and maintenance actions.
- F. Goal: The goal is for end user receipt of reports no more than 10 minutes from the time of the last observation.

## **7.1 Report Formats**

All stations must report data in a format that the Data Ingest and Processing System can decode. The processing system must be in receipt of a station's metadata decodable formats before the

processing system will accept data from that site. An interface control document (ICD) shall be made available for each unique code format available from NERON stations.

### **7.1.1 Time Stamps**

Reports must be time stamped with times in Coordinated Universal Time (UTC).

### **7.1.2 Periodic Reports**

The Data Ingest and Processing System and each station, in combination, must transmit the following reports. The data logger at each station is not necessarily required to transmit each report type if the processing system transmits it based on calculations from shorter time period reports or if sensors are not installed that require a specific report. Each report is independent of and does not include data from any other report but may be transmitted in combination with any of the other reports. The algorithms for each parameter specify what data should be included in each report.

- A. Goal: Special 1-minute report. The goal is for data loggers at stations where 2-way communication is possible to provide the ability for the NERON Operations and Monitoring System to turn on special reports transmitted or recorded at 1-minute intervals to record high-time-resolution data for short periods. The report is valid and time-stamped at M+60.
- B. 5-minute report. The report is valid and time-stamped at 5-minute intervals beginning at H+05 and continuing through H+60.
- C. 15-minute report. The report is valid and time-stamped at 15-minute intervals beginning at H+15 and continuing through H+60.
- D. 30-minute report. The report is valid and time-stamped at H+30 and H+60.
- E. Hourly report. The report is valid and time-stamped at H+60 every hour.
- F. Daily report. The report is valid and time-stamped at 2400 local time every day.

### **7.1.3 Data Logger Reporting of Raw Sensor Data**

Data contained in the reports generated by the data logger at each station must be uncorrected sensor data, with as little processing (e.g., application of calibration coefficients, calculation of precipitation accumulation from load cell or vibrating wire raw output) as possible performed by the data logger. Coefficients and processing will be applied by the Data Ingest and Processing System at ingest while allowing archival of the raw data.

However, the data logger must apply coefficients and process the sensor data supplied to the site host, as described in the processing system algorithm for each parameter, when the site host has an interface that acquires its data directly from the data logger, rather than through an interface that acquires its data through the Data Ingest and Processing System.

## 7.2 Encoding of Report

A processing system shall encode reports at ingest and forward those reports for quality assurance/quality control. The system processing shall be through government furnished equipment and requirements. See the NERON Data Processing System Requirements document for details.

## 7.3 Quality Assurance of Data

The Government shall provide data Quality Assurance (QA). This task will be conducted at a central collection point (or distributed collection sites) after post transmission encoding.

- A. The data logger shall provide as little quality assurance as possible and transmit the data in its raw form, after performing the limited processing described in this document. This will provide the QA system with as much information as possible in troubleshooting sensor problems and will allow maximum flexibility in reprocessing of archived data as algorithms and automated QC routines are improved.
- B. The Government shall provide data QA after transmission. These procedures are described in the Program Development Plan for COOP Modernization and in related NWS directives.

## 7.4 End User Receipt of Reports

The reports need to go from the data logger through the transmission medium to a collection point(s) for encoding and QA, and then to the users. The encoding may occur at one central collection point and the QA at another, or the encoding and QA activities may occur on one or more central processor(s) prior to transmitting the observations to the end users. NWS users must receive the data via the AWIPS. External end users may receive the data via an internet central collection server or via the NWS Gateway and the Family of Services. The method of transmission should have no affect on the content of the observations.

- A. The method for acquiring data from the medium of transmission must be able to meet the latency requirement of 10 minutes from transmission to end user.
- B. The acquisition network may be government furnished or it may be furnished and maintained by the contractor.

# 8 Ambient Air Temperature

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The sensor and data logger must provide temperature measurements from every NERON site.

## 8.1 Air Temperature Accuracy/Resolution

The range of temperatures for the sensor will extend from -65°C to +60°C. The accuracy and resolution are those reported in Table 2. Accuracy is defined as the range within which 99% of the measurement errors must lie during the lifetime of the sensor. The goal is to have an aspirated temperature sensor for warm weather operating zones, though that might not be

possible during the initial deployment. Rates of aspiration will be provided by the Government. The measurement error is the difference between the measured and true values of a parameter for any given observation. Accuracy is usually specified as  $\pm B$ , which indicates the following explicit requirement:  $-B < (X_M - X_T) < B$ , where  $X_M$  and  $X_T$  are the measured and true values of the parameter  $X$ , respectively.

Table 2. Temperature Accuracy/Resolution.

Parameter	Units	Accuracy	Range	Resolution
Temperature	Degrees Celsius	$\pm 0.6^{\circ}\text{C}$	-65 to $-50^{\circ}\text{C}$	$0.06^{\circ}\text{C}$
		$\pm 0.3^{\circ}\text{C}$	-50 to $+50^{\circ}\text{C}$	$0.06^{\circ}\text{C}$
		$\pm 0.6^{\circ}\text{C}$	+50 to $+60^{\circ}\text{C}$	$0.06^{\circ}\text{C}$

## 8.2 Air Temperature Siting Requirements

The sensor shall be placed at 1.5 meters above the ground.

## 8.3 Air Temperature Algorithm — Data Logger

Each site must provide the following reports, obtained using the methods specified for each:

- A. 5-minute air temperature report:
  - i. Record a 5-minute air temperature observation every 5 minutes, beginning with H+05.
    - a. Sample the air temperature at least every 10 seconds over a 5-minute period ending at the time of the observation.
    - b. Average the instantaneous samples.
  - ii. Every 5 minutes, report the 5-minute air temperature in the 5-minute report.
- B. Goal: Special 1-minute report.
  - i. Record a 1-minute air temperature observation every minute.
    - a. Sample the air temperature at least every 10 seconds over a 1-minute period ending at the time of the observation.
    - b. Average the instantaneous samples.
  - ii. Every minute, report the 1-minute air temperature in the 1-minute report.

## 8.4 Air Temperature Algorithm — Processing System

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute air temperature report:
  - i. Report the 5-minute air temperature reported by the logger, corrected with the calibration coefficients specific to each individual sensor, in the 5-minute report.
- B. Average hourly temperature (for USDA evaporative algorithm):
  - i. Average the twelve 5-minute air temperature reports beginning with H+05.
  - ii. Report the average air temperature in the hourly report.
- C. Maximum and minimum (Max/Min) air temperature report from midnight to midnight local time:
  - i. Report the maximum and minimum 5-minute temperatures reported by the data logger in the 288 5-minute reports during the preceding 24 hours ending at 2400 local time in the daily report.
  - ii. Make the range of 5-minute records extend from 0005 to 2400 local time.
  - iii. Time stamp the maximum and minimum measurements with a resolution of five minutes.
- D. Goal: Special 1-minute report.
  - i. Report the 1-minute air temperature reported by the logger, corrected with the calibration coefficients specific to each individual sensor, in the 1-minute report.

## 8.5 Air Temperature Information Display

Sites with COOP observers require a method of displaying the temperature information at the observer's host site. The observer(s) must have a low cost (to the government), user-friendly method to attain current and maximum/minimum temperature data for local use. There is a large supply of GFE temperature displays available in the NWS Logistics and Supply Center; these may or may not be used for NERON.

- Goal: web-based interface or wireless transmission of data from the sensor location to observer's host site.

## 9 Precipitation Accumulation

The sensor and data logger must provide accumulated precipitation measurements at each NERON site.

### 9.1 Precipitation Accumulation Accuracy/Resolution

The resolution must be 0.25 mm. The accuracy requirement is for  $\pm 0.51$  mm or 4 percent of the hourly amount (whichever is greater). Any gauge must operate in an ambient air temperature range from  $-34^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . Table 3 displays the accuracy/resolution requirements.

Table 3. Accuracy/resolution for precipitation accumulation.

Parameter	Units	Accuracy	Range	Resolution
Precipitation Accumulation	mm	$\pm 0.51$ mm or 4% of hourly amount (which ever is greater)	0 to 250 mm h <sup>-1</sup>	0.25 mm

### 9.2 Precipitation Accumulation Siting Requirements

The precipitation gauge catch orifice shall be placed at approximately 0.6 to 2.0 meters above the ground.

### 9.3 Precipitation Accumulation Algorithm — Data Logger

Each site must provide the following reports, obtained using the methods specified for each:

- A. 5-minute raw precipitation sensor output report:
  - i. Report the raw precipitation sensor output every 5 minutes in the 5-minute report. If a tipping bucket gauge is used, report the running total number of tips since 0000 UTC.
- B. Goal: Special 1-minute report.
  - i. Report the raw precipitation sensor output every minute.

### 9.4 Precipitation Accumulation Algorithm — Processing System

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute precipitation accumulation report:
  - i. Report precipitation accumulation, corrected with the calibration coefficients specific to each individual sensor, every 5 minutes in the 5-minute report.
  - ii. Reset precipitation accumulation each night at 2400 UTC.

- iii. If a weighing bucket gauge is used, report the amount of unfilled (reserve) bucket capacity in millimeters of precipitation
- B. 24-hour accumulated precipitation report from midnight to midnight local time:
  - i. Report the total accumulated precipitation for the preceding 24 hours at 2400 local time (i.e., for the ‘previous day’) in the daily report.
  - ii. Make the range of data extend from 0001 to 2400 local time.
- C. Accumulated precipitation reports for variable time intervals will be determined by GFE servers at the Data Ingest and Processing System.
- D. Goal: Special 1-minute report.
  - i. Report precipitation accumulation, as described in A. above, every minute.

## 9.5 Annotation of the Precipitation Record

The ability must exist for manual annotations to the precipitation record. A record notation may be a time-related event or an informational note.

## 10 Augmentation

Human observers at modernized stations must be able to report manually any additional information that the system is incapable of providing automatically. This ability may be independent from the data logger or it may have an interface for the observer to transmit data.

- A. Interfaces for the additional data may be defined as those points of connection between NERON and a human. Thus, an auxiliary method must be in place for the human to report the data. The contractor should provide an estimate of requirements for space (both square footage of floor space and its volume) inside the host facility, and power requirements (power factor, peak load, etc.). If an interface uses data compression during transmittal of data, the compression shall be error free.
- B. The interface shall provide the following elements to be reported from manual measurements:
  - i. Snow depth (6/24 hourly) using GFE
  - ii. Snowfall (6/24 hourly) using GFE
  - iii. Liquid equivalency of snow depth using GFE
  - iv. Nearby river gauge(s) data manually collected by a human using GFE

- v. Other site-specific elements (TBD) using GFE.
- C. Goal: The independent augmentation interface may use an internet form, such as the Automated B-91 internet form at some locations (GFE).
- D. Goal: The special phenomena data stated in NWS Observing Handbook Number 2 will be digitized through an NWS approved code and provided through the human augmentation interface provided to each host (as required).

## **11 Installation**

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Most of the NERON locations are on private property. Installations must be coordinated by the Government. Focal points for each affected WFO will be identified to the installer. A site survey must occur before installation. The site survey must include input from the observer, if any, the installer, and the Government. The installation and operation of NERON equipment shall not adversely impact the capabilities of any host facility.

### **11.1 Power Requirements**

Alternating current (AC) power may not be available at the station for the data logger. There is a need for an alternate power source allowing uninterrupted operation of the data logger. The alternate power source may not be a generator. The alternate power source (e.g., solar panel and Direct Current batteries) must fit within the footprint of the observing site and not interfere with the proper operation of the station. Battery voltage will be an element in each report.

- A. All sites with or without AC power need an uninterruptible power supply (UPS) capable of powering the data logger for a limited time in the absence of host AC power or solar charging. Different sites may use different UPS and recharging systems based on the site conditions (e.g., Arctic winter) to ensure operation for a minimum of 10 days without charging if AC powered and a minimum of 20 days without charging if solar powered.
- B. The UPS system shall be rechargeable by either the host AC power or by a solar panel power supply. Sites not meeting the minimum definition of low sunlight conditions, as defined by the Regional Teams, for every month in the year shall be rechargeable by host AC power, even if a solar panel is also provided.
- C. If a solar panel power supply is used to run and operate the data logger, then the solar panel shall be sized to provide sufficient UPS recharge capability to maintain operations under low sunlight conditions for a period to ensure data availability.

### **11.2 Siting Requirements**

All installations must meet NWS standards for siting and exposure of equipment (See NWS Directive System Instruction 10-1302). In addition, see Appendix B for detailed siting requirements. The standard footprint for a NERON observing site is 10x16 feet, although this

can be expanded under specific equipment requirements. The NERON Transition Program Manager will inform the contractor of the locations where the footprint will be larger. The site must not be affected, or likely to be affected, by local environmental modifiers, (i.e., new construction, irrigation, etc.). NWS Observing Handbook Number 2 has additional information on footprints for COOP observing sites. External equipment shall have protective fencing thwarting theft, vandalism, and livestock or wildlife damage. Legacy equipment at existing sites (CAT-2 sites) replaced by NERON equipment shall be removed and shipped to the NWS Reconditioning Center in accordance with specifications, after a sufficient period of time has passed to allow continuity testing.

### **11.3 Site Acceptance**

The supervising WFO or other designated NWS staff shall coordinate with the contractor to accept the site after installation. Unacceptable site installations shall be resolved by the NWS. A detailed site acceptance plan will be developed by the contractor and the Government.

### **11.4 Commissioning**

Each new station will be commissioned by the NWS. The commissioning process will be in compliance with National Weather Service Policy Directive 80-2.

## **12 Maintenance**

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Maintenance will be provided by the contractor. Reliability of the observing stations and the network's delivery of data which meets the accuracy requirements (referenced in this document) to the end user in real time shall be 96%. Local storage of the data must be 99 percent available. The contractor will perform calibration of the sensors as necessary and as agreed to with the Government. All calibration information will become part of the station's metadata file. The Government is responsible for directing the contractor to perform emergency maintenance. The contractor is responsible for responding to the direction of the Government and for performing routine maintenance. The following must be provided by the contractor:

- A. Well-calibrated sensors. Maintenance technicians may have methods to calibrate selected sensors at NERON sites, rather than removing the equipment solely for the purposes of calibration. This applies to calibration of the data logger, certain sensors (as agreed to by the Government and the contractor), and the communication devices (where applicable).
- B. Preventive maintenance on an agreed to schedule. The maintenance shall cover all of the equipment at the station.
- C. Non-routine and emergency maintenance as required and in response to trouble tickets generated by the Government. The NERON Operations and Monitoring System will be the primary Government contact for the contractor on receiving notification of maintenance actions from the Government. Contractor maintenance response times to outages will be prioritized by site location, sensor type, and season. Prioritization schedules will be negotiated between the Government and the contractor before contract award.

- D. Performance reliability and status reports for individual sensors, each station, and the network.
- E. Solutions to trouble reports provided to the contractor by the Government.
- F. NERON sites shall be configured to allow hardware and software components to be repaired or replaced with the data loss not impacting specified NERON data availability requirements. Approved procedures will predetermine repair or replacement of hardware.
- G. Remote management shall be used as much as possible for fault detection, isolation, diagnosis, recovery, and software upgrade installations and testing.
- H. Maintenance techniques, equipment and spares so that upgrades, tests, and repairs can be performed without impacting the operations of the observing station.
- I. The data logger should include diagnostic tools to facilitate real-time fault isolation to maintain the observing station in operational status.
- J. Develop a communication restoration plan in coordination with the Government.

## **13 Documentation**

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Extensive metadata are required for each site. This metadata will include site physical information, complete sensor information including sensor serial numbers, calibration dates, siting, and exposure information including digital photographs of sites, etc.

- A. NWS will maintain and enhance the current Cooperative Station System Accountability (CSSA) metadata system and users handbook. The CSSA will be available for the contractor to insert relative metadata. The detailed metadata of each station shall be documented in the NWS CSSA. The CSSA is government provided and operated. The contractor must provide the metadata to the NWS through the CSSA. The CSSA Users Handbook describes the metadata in detail.
- B. Logistics, installation and maintenance shall be defined and executed based upon the following contractor-supplied documents: Logistics support plan, installation and acceptance checklists, system operations and training manuals, and maintenance manuals.

## **14 Training**

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The contractor will provide training materials for observer and WFO staff. The training materials must be detailed enough to provide the observer and the NWS the basic knowledge to operate an observing station.

## 15 Technical Documents

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The Contractor must supply the NWS with all relevant technical documents including (but not limited to) basic drawings of instruments, supply catalogs, specification documents, repair and operations documents, and documentation for software algorithms.

## 16 Theory of Operations

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The contractor must provide the NWS all of the characteristics of the observing system including the ability of the data logger to accept new sensors, the expected life-cycle, and the calibration and maintenance requirements.

## 17 Supplies Depot

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The contractor is responsible for maintaining supplies and replacement sensors. There must be adequate spare parts available to maintain each station. Support ability criteria shall be imposed on sensor selection and data logger designs to minimize the life cycle costs.

## 18 Sensor Calibration

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A sensor calibration lab should be used by the contractor.

## 19 Availability

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The availability of each observing station is defined by the station's data availability to the end user. Sensor availability is defined by each sensor's data being available to the end user, while the availability of the network is defined by the network data availability.

### 19.1 Observing Station's Data Availability

Observing Station Availability ( $A_O$ ) is defined as the average proportion of time that a station is operable. ( $A_O$ ) is calculated monthly using the following equation:

$$A_O = \frac{MTBF - MOT}{MTBF}$$

where,

$$MTBF = \text{Mean Time Between Failures or Outages} = \frac{\text{Number of Operating Hours}}{\text{Number of Outage Events}}$$

$$MOT = \text{Mean Outage Time (in hours)} = MTTR + MSRT + MMDT + MOLDT$$

where,

MTTR = Mean Time To Repair, including fault isolation, removal and replacement, checkout, and restart time.

MSRT = Mean Supply Response Time waiting for arrival of required spare parts at an observing station.

MMDT = Mean Maintenance Delay Time waiting for the arrival of maintenance personnel at a site.

MOLDT = Mean Other Logistics Delay Time awaiting test equipment, documentation, more highly trained personnel, or any other delay in returning to operational status.

For the purpose of calculating ( $A_O$ ), outage time will not include routine scheduled maintenance (e.g., cleaning sensor), provided it is infrequent and does not occur during weather when the parameter is critical. Each individual station shall have a minimum overall operational availability ( $A_O$ ) of 96%. A station is considered operational, if it has produced all the required reports with all the sensor data and staged them to the communications port by the specified time. No outage will be ascribed to a failure of common communication carrier that is outside of the control of the NERON. Requirements for maintenance actions will follow the restoration schedules developed in Section 12.B.

## 19.2 Sensor Data Availability

Sensor Data Availability ( $A_S$ ) is defined as an averaged probability that the sensor is operable over a period of time. Sensor  $A_S$  is calculated monthly using the same equation as for  $A_O$ . Maintenance action for individual sensors will follow restoration priorities as described in Section 12.B.

## 19.3 Network Data Availability

The data availability for NERON network must be 96%. The goal is for 98%. Data availability is defined as the ratio of the actual number of data records that are available to users within the specified transmission time lines divided by the total number of data records that would be available if all stations reported all required reports on time. The data availability is computed using a monthly average.

# 20 Operating Zones

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The sensors must work in a variety of environments. For the purposes of this document, environmental conditions are designated as one of four operating zones. The operating zone conditions may further be grouped into two ranges: standard and extended. The standard range would typically be wide enough to contain the environmental stresses 99% of the time. Sensors should operate reliably and within sensor performance specifications under prolonged exposures to the standard range of environmental conditions. The extended range is an attempt to place an outer limit on the environmental stresses under which the instrument suite will survive. Sensors may not function reliably and/or the measured data may not be accurate, while operating in the extended range. The sensors should automatically return to full performance after exposure to the extended conditions has ended and the environmental conditions return to the standard range. If a specific value for an extended range is not indicated, then the extended range can be assumed to be the same as the standard range.

- A. NWS Standard Environmental Criteria and Test Procedures, WS-STD-2, Oct. 8, 1984 - describes the procedures used to verify compliance with environmental conditions.

Table 4. Operating zone conditions.

Zone Condition Limits	Extreme	Extreme Cold	Extreme Warm	Moderate
Min Temperature (Standard / Extended)	-57 / -65°C	-51 / -65°C	-29 / -40°C	-29 / -40°C
Max Temperature (Standard / Extended)	60 / 66°C	50 / 60°C	60 / 66°C	50 / 60°C
Snow Load (Standard)	235 kg m <sup>-2</sup>	235 kg m <sup>-2</sup>	25 kg m <sup>-2</sup>	25 kg m <sup>-2</sup>
Wind Steady (Standard / Extended)	16 / 38 m s <sup>-1</sup>	16 / 38 m s <sup>-1</sup>	16 / 38 m s <sup>-1</sup>	16 / 38 m s <sup>-1</sup>
Wind Gusts (Standard / Extended)	24 / 50 m s <sup>-1</sup>	24 / 50 m s <sup>-1</sup>	24 / 50 m s <sup>-1</sup>	24 / 50 m s <sup>-1</sup>
Ice accretion (Standard)	25 mm	25 mm	2.5 mm	2.5 mm
Relative Humidity (Standard / Extended)	74% @ 35°C / 45% @ 43°C	74% @ 35°C / 45% @ 43°C	74% @ 35°C / 45% @ 43°C	74% @ 35°C / 45% @ 43°C
100% Humidity (Standard / Extended)	27 / 29°C	27 / 29°C	27 / 29°C	27 / 29°C
Elevation Range (Standard)	0 to 3,700 m	0 to 3,700 m	0 to 3,000 m	0 to 3,000 m

- B. NWS will designate each site as operating in one of 4 operating zones, with the required standard and extended operating range as defined in Table 4.
- i. All sensor and data logger performance specifications in this PFRD shall be met when operating within the standard operating range defined for the zone where the station is located.
  - ii. All sensor and data logger performance specifications in this PFRD shall be met, with the exception of data availability and data accuracy requirements when operating outside the standard operating range but within the extended operating range defined for the zone where the station is located.
  - iii. The system shall not suffer any permanent damage when operating within the extended range for the zone where the station is located and will return to normal operations when the conditions return to within the standard range.

## 21 Transportability and Storage

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The NERON equipment must be capable of surviving normal shipping and storage conditions without damage.

- A. NWS Standard Environmental Criteria and Test Procedures, WS-STD-2, October 8, 1984 - describes the procedures used to verify compliance with environmental conditions.
- B. All system components shall be transportable via commercial shipping.
- C. All system components, when transported or in storage, shall meet all requirements of this specification after exposure to any combinations of the conditions in Table 5.

Table 5. Transport conditions.

Transport Conditions	
Temperature	-65 to 66°C
Humidity	Up to 100% @ 30°C
Precipitation	76 mm h <sup>-1</sup> @ 16 m s <sup>-1</sup>
Altitude	-150 to 4,600 m MSL
Vibration	3-5 Hz with acceleration of 9.8 m s <sup>-2</sup>
Handling (Transit)	Up to 0.8 m drop

## 22 Flexibility and Expansion of System

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The station equipment design shall be modular to allow various components to be plugged in without modification. For example, one should be able to replace one type of temperature sensor with a different type of sensor without making significant changes to the data logger. The software operating in the data logger shall easily permit adding or changing sensor algorithms, sampling periods and other software associated with sensors or communication devices.

## 23 Design and Construction

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The data logger, sensors and communication devices shall be constructed of COTS parts to the maximum extent possible.

## 24 Human Engineering

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The operator-hardware and operator-software interfaces will be designed to maximize safety, efficiency, and usability, and minimize the number of personnel resources, skills, and training required.

## 25 System Security

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The data logger shall be capable of selectively denying access to data while meeting all data collection and processing requirements. Access to the data logger shall be password protected.

## 26 Data Logger Resource Reserve Capacity

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The design and installation of the data logger storage, processing, communication and sensor interfaces equipment shall be such that equipment modifications may be readily made after the initial installation to meet the growth requirements. The data logger shall have a capacity for 100 percent built-in growth margin over the data logger baseline requirements as described in Section 6. The data logger hardware, software, and memory must have the capacity to be expanded through modular add-on data logger hardware. These add-ons to the baseline data logger will provide enhanced transmission and ingest processes, and allow for a total of twenty-four sensors/communication devices, acquired by the contractor to meet expanding requirements of specific sites. The requirements for the data logger with the add-ons are the same as those described in Section 6.

## 27 Precedence

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The requirements in this specification are not of equal importance. The weighting factors incorporated in this specification:

1. *Shall, will, is, or must* designates the most important weighting level; ( i.e. mandatory). Any deviations from these contractually imposed mandatory requirements require the approval of the contracting officer.
2. *Should or may* designates requirements requested by the government and are not mandatory. Unless required by other contract provisions, noncompliance with the “*should*” or “*may*” requirements does not require approval of the contracting officer.

## 28 Verification and Quality Assurance Provisions

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TBS (insert applicable NWS test documents from the reference document list)

### 28.1 General Requirements

#### 28.1.1 Verification

The contractor is responsible for performing acceptance verification tests. The government is responsible for developing an Operational Acceptance Test (OAT) plan. The Government will monitor and assess the contractor’s acceptance verification tests in coordination with the contractor.

- A. The system shall be designed so that all requirements contained herein can be verified as specified in Section 28.1.2.

- B. Verification shall be carried out in accordance with approved procedures. (See applicable contract requirements to determine which procedures require government approval.) In the case of verification by test (as defined in Section 28.1.2.2), the procedure shall identify the specific test instrumentation (hardware and/or software) and/or special test equipment used.
- C. Requirements of Sections 3 through 26 shall be verified by the methods specified for each requirement in the contractor's "System and Segment" specifications as shown in the contractor's Verification Matrix.
- D. The verification methods used shall be in accordance with the methods specified in Section 28.1.2.

## **28.1.2 Verification Methods**

### **28.1.2.1 Demonstration**

Demonstration is an exhibition of the ability to operate and/or support an item under intended service use conditions. Sufficient data for requirements verification can be obtained by observing functional operation of the system, or a part of the system, without the use of instrumentation or special test equipment beyond that inherently provided in the system being verified.

### **28.1.2.2 Test**

Test is the verification method by which the operability, support ability, performance capability or other specified qualities of an item are verified when subjected to controlled conditions, real or simulated. These verifications may require use of special test equipment and instrumentation that are not an integral part of the system being verified to obtain quantitative data for analysis, as well as qualitative data derived from displays and indicators inherent in the item(s) for monitor and control.

### **28.1.2.3 Analysis**

Analysis is the verification method used to verify requirements by determining qualitative and quantitative properties and performance of the system by studying and examining engineering drawings, software, and hardware flow diagrams, software and hardware specifications, and other software and hardware documentation (e.g., COTS vendor documentation). It also includes performing modeling, simulation, and/or calculations and analyzing the results. Analysis techniques include interpretation or interpolation/extrapolation of analytical or empirical data collected under defined conditions or reasoning to show theoretical compliance with requirements.

### **28.1.2.4 Inspection**

Inspection is the verification method used to verify characteristics of an item by inspecting engineering documentation produced during development or by inspection of the product itself to verify conformance with specified requirements. Inspection is nondestructive and consists of visual inspections or simple measurements without the use of precision measurement equipment.

The Government may conduct inspection testing at the vendors facility in coordination with the contractor.

#### **28.1.2.5 Similarity**

Similarity is the process of comparing a current item with a previous item taking into consideration configuration, test data, application and/or environment. The evaluation should be documented and shall include: the test procedures/reports of the item to which similarity is claimed; a description of the difference(s) between the items; and the rationale for verification by similarity.

#### **28.1.2.6 Records**

Complete records indicating relevant verification data, including the application of all parts, materials, and control requirements. The verification procedures required by this section, and all nonconformance reports, if any, shall be maintained for the system items and made available for review during the service life of the system.

### **28.2 Qualification Test Requirements**

- A. Similarity analysis may be used in lieu of the test or demonstration methods for qualification of a system element when it can be shown the item is identical in design to an item previously qualified to equivalent or more stringent criteria.
- B. If similarity analysis cannot be used, qualification shall be in accordance with Section 28.3.
- C. Verification shall be carried out in accordance with a verification procedure approved by the Government.
- D. In the case of verification by test, the procedure shall identify the test instrumentation (hardware and/or software) and/or special test equipment used.
- E. One of each type of sensor shall be subject to qualification testing conducted by the contractor.

### **28.3 Acceptance Test Requirements**

- A. Base resource requirements shall be verified at acceptance testing, and will comprise the projected capacity (sensor performance, data logger memory, storage, processing speed, transmission speed, etc.) required to deliver reports from the full complement of NERON stations.
- B. All of the equipment required for one fully capable observation station shall be subject to end-to-end acceptance testing conducted by the contractor.
- C. The system shall be subjected to end-to-end acceptance testing by the Government.

- D. The system acceptance criteria shall verify all performance requirements have been satisfied. The Government and the contractor shall jointly agree on acceptance.
- E. The contractor shall certify system readiness to begin the Government's operational acceptance test.

## **29 Preparation for Delivery**

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- A. Deliverable items shall be packed and handled in such a manner as to protect them against vibrations, shocks, moisture, or contamination.
- B. Protection shall be provided against natural environmental conditions.
- C. Provisions for inspection and handling shall exist for all deliverable items.

### **29.1 Serial Numbers**

Serial numbers must be assigned to and attached to each sensor and unit of equipment tracked in the NERON metadata system. If equipment is not assigned a serial number by the manufacturer, then the contractor initially receiving that equipment from the vendor must assign and label the equipment with a serial number following the convention listed in both the NERON Site Installation Plan and the NERON Site Maintenance Plan.

### **29.2 Marking of Shipment**

The exterior of each NERON package and each shipping container shall be clearly marked to identify its contents.

## Appendix A. Enhanced Site Standard

This Appendix describes the NERON Enhanced Site Standards with sensors beyond the NERON Baseline Site Standards. The algorithms, including sampling periods, are in Appendix A. Whenever an element is added to the baseline system, the standards in this Appendix shall be followed. The sensors required for any of these elements will meet the standards described herein. The contractor will acquire and install any sensors for Enhanced sites as an option to the contract as instructed. A site layout plan will be coordinated between the contractor and the Government. Additional elements may be included in this Appendix at a later time.

### A1 Operational Wind

The optional requirement is for a wind direction, speed, and gust element for use in operational forecasting.

#### A1.1 Operational Wind Accuracy/Resolution

The range of measurement is from 1 to 360 degrees and 1 to 64 m s<sup>-1</sup>. The accuracy and resolution requirements are provided in Table A-1.

Table A-1. Operational winds accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Direction	degrees	±3 degrees when speed is ≥2.6 m s <sup>-1</sup>	1 to 360 degrees	0.05 degrees
Speed and Character	m s <sup>-1</sup>	±0.5 m s <sup>-1</sup>	0 to 64 m s <sup>-1</sup>	0.5 m s <sup>-1</sup>

#### A1.2 Operational Wind Siting Requirements

The siting and exposure of the operational Wind element shall follow the standards in NWS 10-1302 for climatological standards. The sensors shall be mounted on a 10-meter tower.

#### A1.3 Operational Wind Algorithm — Data Logger

This algorithm shall be used until superseded. Each site must provide the following reports obtained using the methods specified for each:

- A. 5-minute average wind speed report:
  - i. Sample the wind speed and direction every 1 second for each 5-minute period.
  - ii. Compute the magnitude of the vector average of the samples each 5 minutes.

- iii. Every 5 minutes, report the 5-minute vector average wind speed in the 5-minute report.
- B. 5-minute average wind direction report:
  - i. Sample the wind direction and speed every 1 second for each 5-minute period.
  - ii. Compute the direction of the vector average of the samples each 5 minutes.
  - iii. Every 5 minutes, report the 5-minute vector average wind direction in the 5-minute report.
- C. 5-minute maximum wind report:
  - i. Sample the wind speed and direction every 1 second for each 5-minute period.
  - ii. Determine the maximum wind speed and the associated wind direction, from the 300 1-second samples.
  - iii. Every 5 minutes, report the maximum wind speed and its associated direction in the 5-minute report.
- D. Goal: Special 1-minute report:
  - i. 1-minute average wind speed report:
    - a. Sample the wind speed and direction every 1 second for each 1-minute period.
    - b. Compute the magnitude of the vector average of the samples each minute.
    - c. Every minute, report the 1-minute vector average wind speed in the 1-minute report.
  - ii. 1-minute average wind direction report:
    - a. Sample the wind direction and speed every 1 second for each 1-minute period.
    - b. Compute the direction of the vector average of the samples each minute.

- c. Every minute, report the 1-minute vector average wind direction in the 1-minute report.
- iii. 1-minute maximum wind report:
  - a. Sample the wind speed and direction every second for each 1-minute period.
  - b. Determine the maximum wind speed and the associated wind direction, from the sixty 1-second samples.
  - c. Every minute, report the maximum wind speed and its associated direction in the 1-minute report.

#### **A1.4 Operational Wind Algorithm — Processing System**

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute average wind speed report:
  - i. Report the 5-minute average wind speed reported by the data logger in the 5-minute report.
- B. 5-minute average wind direction report:
  - i. Report the 5-minute average wind direction reported by the data logger in the 5-minute report.
- C. 5-minute maximum wind report:
  - i. Report the 5-minute maximum wind speed and associated direction reported by the data logger in the 5-minute report.
- D. Hourly average wind speed report:
  - i. Compute the magnitude of the vector average of the twelve 5-minute wind vectors derived from A. and B. above, beginning with the report collected at H+05.
  - ii. Report the hourly vector average wind speed in the hourly report.
- E. Hourly average wind direction report:
  - i. Compute the direction of the vector average of the twelve 5-minute wind vectors derived from A. and B. above, beginning with the report collected at H+05.

- ii. Report the hourly vector average wind direction in the hourly report.
- F. Hourly maximum wind report:
  - i. Determine the maximum wind speed from the twelve 5-minute maximum wind speeds reported in C. above, beginning with the report collected at H+05.
  - ii. Report the hourly maximum wind speed, its associated wind direction, and time of occurrence in the hourly report.
- G. Daily average wind speed report:
  - i. Compute the magnitude of the vector average of the 24 hourly average wind vectors derived from D. and E. above, beginning with the report collected at 0005 local time.
  - ii. Report the 24-hour vector average wind speed in the daily report.
- H. Daily average wind direction report:
  - i. Compute the direction of the vector average of the 24 hourly average wind vectors derived from D. and E. above, beginning with the report collected at 0005 local time.
  - ii. Report the 24-hour average wind direction in the daily report.
- I. Daily maximum wind report:
  - i. Determine the maximum wind speed from the 24 hourly maximum wind speeds reported in F. above, beginning with the report collected at 0100 local time.
  - ii. Report the daily maximum wind speed, its associated wind direction, and time of occurrence in the daily report.
- J. Goal: Special 1-minute report:
  - i. Report the 1-minute average wind speed observation reported by the data logger in the 1-minute report.
  - ii. Report the 1-minute average wind direction observation reported by the data logger in the 1-minute report.

- iii. Report the 1-minute maximum wind speed and associated direction reported by the data logger in the 1-minute report.

## A2 Wind Speed for Evaporation

The USDA requirement is for a wind element to compute evaporative data.

### A2.1 Wind Speed for Evaporation Accuracy/Resolution

The range of measurement for wind speed is 0 to 60 meters per second. The accuracy and resolution requirements are provided in Table A-2.

Table A-2. Wind speed for evaporation accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Wind Speed	m s <sup>-1</sup>	±0.3 m s <sup>-1</sup> above 1.0 m s <sup>-1</sup>	0 to 60 m s <sup>-1</sup>	0.03 m s <sup>-1</sup> over entire scale

### A2.2 Wind Speed for Evaporation Siting Requirements

The sensor to meet this requirement should be on a tower with exposure to provide an unobstructed wind field. The NWS instruction 10-1302 provides standards for exposure for wind fields. The sensor should be mounted at a height of 2 meters. There may be mathematical coefficients applied to appropriately account for sensor height on a tower.

### A2.3 Wind Speed for Evaporation Algorithm — Data Logger

This algorithm shall be used until superseded. Each site must provide the following reports obtained using the methods specified for each:

- A. 5-minute average wind speed report:
  - i. Sample the wind speed at least every 10 seconds for each 5-minute period.
  - ii. Average the samples each 5 minutes.
  - iii. Every 5 minutes, report the 5-minute average in the 5-minute report.
- B. 5-minute maximum wind speed report:
  - i. Sample the wind speed every 10 seconds for each 5-minute period.
  - ii. Determine the maximum wind speed from the thirty 10-second samples.
  - iii. Every 5 minutes, report the maximum wind speed in the 5-minute report.

- C. Goal: Special 1-minute report:
  - i. 1-minute average wind speed report:
    - a. Sample the wind speed at least every 10 seconds for each 1-minute period.
    - b. Average the samples each minute.
    - c. Every minute, report the 1-minute average in the 1-minute report.
  - ii. 1-minute maximum wind speed report:
    - a. Sample the wind speed every 10 seconds for each 5-minute period.
    - b. Determine the maximum wind speed from the six 10-second samples.
    - c. Every minute, report the maximum wind speed in the 1-minute report.

#### **A2.4 Wind Speed for Evaporation Algorithm — Processing System**

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute average wind speed report:
  - i. Report the 5-minute average wind speed reported by the data logger in the 5-minute report.
- B. 5-minute maximum wind speed report:
  - i. Report the 5-minute maximum wind speed reported by the data logger in the 5-minute report.
- C. Hourly average wind speed report:
  - i. Average the twelve 5-minute average wind speeds reported in A. above, beginning with the report collected at H+05.
  - ii. Report the hourly average wind speed in the hourly report.

- D. Hourly maximum wind speed report:
- i. Determine the maximum wind speed from the twelve 5-minute maximum wind speeds reported in B. above, beginning with the report collected at H+05.
  - ii. Report the hourly maximum wind speed in the hourly report.
- E. Daily average wind speed report:
- i. Average the 24 hourly average wind speeds reported in C. above, beginning with the report collected at 0005 local time.
  - ii. Report the 24-hour average wind speed in the daily report.
- F. Daily maximum wind speed report:
- i. Determine the maximum wind speed from the 24 hourly average wind speeds reported in D. above, beginning with the report collected at 0005 local time.
  - ii. Report the 24-hour maximum wind speed in the daily report.
- G. Goal: Special 1-minute report:
- i. Report the 1-minute average wind speed reported by the data logger in the 1-minute report.
  - ii. Report the 1-minute maximum wind speed reported by the data logger in the 1-minute report.

## A3 Relative Humidity

The USDA requirement is for an element to report relative humidity information in order to compute evaporative data.

### A3.1 Relative Humidity Accuracy/Resolution

The range of measurement for relative humidity is zero to 100%. The accuracy and resolution requirements are provided in Table A-3.

Table A-3. Relative humidity accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Relative Humidity	Percent	±3% (10% – 90%) ±5% (otherwise)	0.8 to 100% non-condensing water vapor	0.05% over full scale

### **A3.2 Relative Humidity Siting Requirements**

The siting and exposure of the relative humidity sensor shall follow the standards for ambient air temperature. Refer to Section 8.2 above.

### **A3.3 Relative Humidity Algorithm — Data Logger**

This algorithm shall be used until superseded. Each site must provide the following reports obtained using the methods specified for each:

- A. 5-minute relative humidity report:
  - i. Sample the relative humidity at least every 10 seconds over a 5-minute period ending at the time of the observation.
  - ii. Average the instantaneous samples.
  - iii. Every 5 minutes, report the 5-minute relative humidity in the 5-minute report.
- B. Goal: Special 1-minute report.
  - i. Sample the relative humidity at least every 10 seconds over a 1-minute period ending at the time of the observation.
  - ii. Average the instantaneous samples.
  - iii. Every minute, report the 1-minute relative humidity in the 1-minute report.

### **A3.4 Relative Humidity Algorithm — Processing System**

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute relative humidity report:
  - i. Report the 5-minute relative humidity value reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, if applicable, in the 5-minute report.
- B. Average hourly relative humidity:
  - i. Average the twelve 5-minute relative humidity reports beginning with H+05.
  - ii. Report the average hourly relative humidity in the hourly report.
- C. Goal: Special 1-minute report:

- i. Report the 1-minute relative humidity value reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, if applicable, in the 1-minute report.

## A4 Dew Point

The optional requirement is for an element to provide dew point data for use in operational forecasting. It is the intent as of this writing to calculate dew point using relative humidity, temperature, and pressure data unless a dew point sensor is specifically required. If a dew point sensor is used, the following functional requirements apply.

### A4.1 Dew Point Accuracy/Resolution

The range of measurement is from -37°C to 30°C. The accuracy and resolution requirements are provided in Table A-4.

Table A-4. Dew point accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Dew Point	Degrees Celsius	±2.2°C	-37 to -31°C	0.06°C
		±1.7°C	-31 to -1°C	0.06°C
		±1.1°C	-1 to +30°C	0.06°C

### A4.2 Dew Point Siting Requirements

The siting and exposure of the dew point sensor shall follow the standards for ambient air temperature. Refer to Section 8.2 above.

### A4.3 Dew Point Algorithm — Data Logger

This algorithm shall be used until superseded. Each site must provide the following reports obtained using the methods specified for each:

- A. 5-minute dew point report:
  - i. Sample the dew point at least every 10 seconds over a 5-minute period ending at the time of the observation.
  - ii. Average the instantaneous samples.
  - iii. Every 5 minutes, report the 5-minute dew point in the 5-minute report.
- B. Goal: Special 1-minute report.

- i. Sample the dew point at least every 10 seconds over a 1-minute period ending at the time of the observation.
- ii. Average the instantaneous samples.
- iii. Every minute, report the 1-minute dew point in the 1-minute report.

#### **A4.4 Dew point Algorithm — Processing System**

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute dew point report:
  - i. Report the 5-minute dew point value reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, if applicable, in the 5-minute report.
- B. Average hourly dew point:
  - i. Average the twelve 5-minute dew point reports beginning with H+05.
  - ii. Report the average hourly dew point in the hourly report.
- C. Goal: Special 1-minute report:
  - i. Report the 1-minute dew point value reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, if applicable, in the 1-minute report.

### **A5 Water Vapor Detection**

The optional requirement is for a water vapor element for use in operational forecasting and numerical weather prediction.

#### **A5.1 Water Vapor Detection Accuracy/Resolution**

The range of measurement are TBD. The accuracy and resolution requirements are provided in Table A-5.

Table A-5. Water vapor accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Water Vapor	TBD	TBD	TBD	TBD

#### **A5.2 Water Vapor Siting Requirements**

The siting and exposure of the water vapor element shall follow the standards TBD.

## A5.3 Water Vapor Detection Algorithm

The algorithm is TBD.

## A6 Solar Radiation

The USDA requirement is for an element to report solar radiation data, necessary to compute evaporative data.

### A6.1 Solar Radiation Accuracy/Resolution

The wavelength for solar radiation is 400 to 1100 nanometers (nm). The accuracy and resolution requirements are provided in Table A-6.

Table A-6. Solar radiation accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Solar Radiation	$\text{W m}^{-2}$ (sensitivity $0.2 \text{ kW m}^{-2} \text{ V}^{-1}$ )	$\pm 5\%$ of the reading	0 to $1500 \text{ W m}^{-2}$	$0.25 \text{ W m}^{-2}$ over full scale

### A6.2 Solar Radiation Siting Requirements

The site for solar radiation should be free from obstructions to the solar beam at all times and seasons of the year. The siting shall be selected so the incidence of restrictions to visibility will be typical of the surrounding area.

### A6.3 Solar Radiation Algorithm — Data Logger

This algorithm shall be used until superseded. Each site must provide the following reports obtained using the methods specified for each:

- A. 5-minute solar radiation report:
  - i. Sample the solar radiation at least every 10 seconds over a 5-minute period ending at the time of the observation.
  - ii. Average the instantaneous samples.
  - iii. Every 5 minutes, report the 5-minute solar radiation in the 5-minute report.
- B. Goal: Special 1-minute report:
  - i. Sample the solar radiation at least every 10 seconds over a 1-minute period ending at the time of the observation.
  - ii. Average the instantaneous samples.

- iii. Every minute, report the 1-minute solar radiation in the 1-minute report.

## A6.4 Solar Radiation Algorithm — Processing System

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute solar radiation report:
  - i. Report the 5-minute solar radiation reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, in the 5-minute report.
- B. Average hourly solar radiation report:
  - i. Average the twelve 5-minute solar radiation reports beginning with H+05.
  - ii. Report the average hourly solar radiation in the hourly report.
- C. Total daily solar radiation report:
  - i. ?
- D. Goal: Special 1-minute report:
  - i. Report the 1-minute solar radiation reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, in the 1-minute report.

## A7 Barometric Pressure

The optional requirement is for a station barometric pressure element.

### A7.1 Barometric Pressure Accuracy/Resolution

The range of measurement for barometric pressure is 600 to 1060 millibars (mb). The accuracy and resolution requirements are provided in Table A-7.

Table A-7. Barometric pressure accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Barometric Pressure	hPa or mb	±0.4 mb	600 mb to 1100 mb	0.01 mb over full scale

### A7.2 Barometric Pressure Siting Requirements

The exposure of the pressure sensor should be protected from windy conditions but available to the natural atmosphere.

### **A7.3 Barometric Pressure Algorithm — Data Logger**

This data shall be reported on each NERON 5-minute report. This algorithm shall be used until superseded.

- A. 5-minute barometric pressure report:
  - i. Sample the barometric pressure at least every 10 seconds over a 5-minute period ending at the time of the observation.
  - ii. Average the instantaneous samples.
  - iii. Every 5 minutes, report the 5-minute barometric pressure in the 5-minute report.
- B. Goal: Special 1-minute report.
  - i. Sample the barometric pressure at least every 10 seconds over a 1-minute period ending at the time of the observation.
  - ii. Average the instantaneous samples.
  - iii. Every minute, report the 1-minute barometric pressure in the 1-minute report.

### **A7.4 Barometric Pressure Algorithm — Processing System**

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. 5-minute barometric pressure report:
  - i. Report the 5-minute barometric pressure value reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, if applicable, in the 5-minute report.
- B. 5-minute sea-level pressure report:
  - i. Calculate sea-level pressure, based on the reported barometric pressure, air temperature, station elevation, and standard lapse rate defined for the station in the 5-minute report.
- C. Goal: Special 1-minute report:
  - i. Report the 1-minute barometric pressure value reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, if applicable, in the 1-minute report.

## A8 Soil Temperature

The United States Department of Agriculture (USDA) requirement is for soil temperature to be measured at 5 cm, 20 cm, and 50 cm below the surface of the ground. The goal is for additional measurements at 2 cm and 10 cm. Where it is not possible to get the deeper depths, installation should follow the depth guidelines beginning at 2 cm and proceeding downward until hitting bedrock or soil that is too rocky for sensor installation.

### A8.1 Soil Temperature Accuracy/Resolution

The range of measurement for soil temperature is -10°C to 65°C. The accuracy and resolution requirements are provided in Table A-8.

Table A-8. Soil temperature accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Soil Temperature	Degrees Celsius	±0.5°C	-30 to 65°C	0.03°C

### A8.2 Soil Temperature Siting Requirements

The site for soil moisture measurements should be a level plot of ground of about 0.6 meters square in soil typical of the surrounding ground. The soil temperature sensors shall be installed at the following depths below ground level: 5, 10, 20, 35, and 50 cm.

### A8.3 Soil Temperature Algorithm — Data Logger

This algorithm shall be used until superseded. Each site must provide the following reports obtained using the methods specified for each:

- A. Hourly soil temperature report:
  - i. Every hour, report the instantaneous soil temperature sample in the hourly report.

### A8.4 Soil Temperature Algorithm — Processing System

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. Hourly soil temperature report:
  - i. Report the hourly soil temperature reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, in the hourly report.
- B. Average daily soil temperature report:

- i. Average the 24 hourly soil temperature values reported, beginning with the report collected at 0100 local time.
- ii. Report the 24-hour average soil temperature in the daily report.

## **A9 Soil Moisture**

The USDA requirement is for soil moisture measurements at 5 cm, 20 cm, and 50 cm below the surface of the ground. The goal is for moisture measurements additionally at 2 cm and 10 cm. Not all locations will accommodate all depths. Where it is not possible to reach the deeper depths, installation should follow the depth guidelines beginning at the 2 cm level and proceeding downward until hitting bedrock or soil that is too rocky for sensor installation. Soil moisture and soil temperature shall use the same sensor.

### **A9.1 Soil Moisture Accuracy/Resolution**

The range of measurement for soil moisture is zero to 100%. The accuracy and resolution requirements are provided in Table A-9.

Table A-9. Soil moisture accuracy/resolution.

Parameter	Units	Accuracy	Range	Resolution
Soil Moisture	Volumetric Water (%)	±3%	Zero to 100%	0.5% over full scale

### **A9.2 Soil Moisture Siting Requirements**

The site for soil moisture measurements should be a level plot of ground of about 0.6 meters square in soil typical of the surrounding ground. The composition of the soil must be provide as part of the metadata. Specialized care must be used during installation to avoid creating water channels to the sensors.

### **A9.3 Soil Moisture Algorithm — Data Logger**

This algorithm shall be used until superseded. Each site must provide the following reports obtained using the methods specified for each:

- A. Hourly soil moisture report:
  - i. Every hour, report the instantaneous soil moisture sample in the hourly report.

### **A9.4 Soil Moisture Algorithm — Processing System**

The Data Ingest and Processing System must provide the following reports based on the reports provided by the data logger at each station, obtained using the methods specified for each:

- A. Hourly soil moisture report:

- i. Report the hourly soil moisture value reported by the data logger, corrected with the calibration coefficients specific to each individual sensor, in the hourly report.
- C. Average daily soil moisture report:
  - i. Average the 24 hourly soil moisture values reported, beginning with the report collected at 0100 local time.
  - ii. Report the 24-hour average soil moisture in the daily report.

## **A10 Chemical and Biological Detection**

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The optional requirement is for a chemical and biological detection element for use in homeland security activities.

### **A10.1 Chemical and Biological Accuracy/Resolution**

The range of measurement are TBD. The accuracy and resolution requirements are provided in Table A-10.

Table A-10. Chemical and biological detection accuracy/resolution.

<b>Parameter</b>	<b>Units</b>	<b>Accuracy</b>	<b>Range</b>	<b>Resolution</b>
Chemical	TBD	TBD	TBD	TBD
Biological	TBD	TBD	TBD	TBD

### **A10.2 Chemical and Biological Detection Siting Requirements**

The siting and exposure of the Chemical and Biological Detection element shall follow the standards TBD.

### **A10.3 Chemical and Biological Detection Algorithm**

The algorithm is TBD.

## **A11 Amending this Appendix**

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As additional requirements are presented by the National Weather Service and our partners, this Appendix may be amended.

## Appendix B. Siting Requirements

This appendix describes siting standards to be followed in selecting NERON sites. The most desirable landscape surrounding a proposed modernized site is an open area that is relatively large and flat with low vegetation so that the horizon can be viewed in an unobstructed manner in all directions except at low elevation angles above the horizon.

### B1 General Guidance

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In general, locations that have long-term climate records and a measure of climate variability are of high value. Selected locations must provide representative real-time weather information and have siting exposure that is expandable to meet future needs. The site location should be representative of the climate of the region, and not be heavily influenced by unique local topographic and mesoscale/microscale features/factors.

There must be a reasonably high probability that selected sites and surrounding areas will be relatively stable over many decades. The risk of encroachments over time and/or the chance the site will close due to the sale of the land or other factors must be minimized. Legacy stations or new stations located on institutions, small community airports, government (federal, state, local) land or at colleges (granted/deeded land with land use restrictions) often provide a higher stability factor. Avoid high-risk sites such as:

- flood plains (low areas adjacent to river basins, estuaries, and coastal offshore barrier islands/beaches);
- enclosed locations that may “trap” air and create unusually high incidents of fog, cold air advection;
- areas subject to orographically induced winds;
- complex meteorological zones, such as those adjacent to oceans or other large bodies of water; or
- areas subject to prolonged periods with extreme snow depths (e.g., several meters/tens of feet).

As a guide, land that will undergo periodic agricultural projects, such as regular tilling, should be a minimum of 90 meters (~300 feet) from the proposed instrument site.

The distance between an AC source and the instrument site should be as short as possible, typically less than 300 feet.

### B2 Prioritized List of Site-Selection Criteria (High to Low)

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1. High-quality siting and exposure meeting climate principles
2. Long-term stability of the instrument sites—low risk of being asked to leave the location during the next 50 years and low risk of significant changes to the surrounding area

3. Microscale features in the nearby landscape must not dominate the synoptic and mesoscale climate signals
4. NERON sites where access to a LETS hub may be attained. New sites established to improve the LETS/NERON linkage could include sites established on the tops of strategically-located mountain ridges or at LETS agencies deemed to have White or Green exposures.
5. Year-round access for maintenance visits (scheduled or unscheduled)
6. Nearby access to AC power (solar power is an option)
7. Legacy COOP sites with sensor exposures that are Blue or better *and* meet specific, identifiable needs of the local NWS weather forecast offices (WFOs) and river forecast centers (RFCs).
8. Legacy COOP sites with sensor exposures that are Blue or better *and* are part of the hourly precipitation data network (HPD).
9. Legacy COOP sites with sensor exposures that are Blue or better *and* are part of the historical climate network (HCN).
10. New sites that fulfill a spatial void *and* have a site exposure rated White or Green. New site examples include small community or sub-regional airports, agricultural research farms, etc.

### **B3 Local Site Representativeness Evaluation (Classification Scheme)**

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Local environmental and nearby terrain factors have an influence on the *quality* of a measurement. The selection of an instrument site will be the result of a balance between competing demands, such as those highlighted in the prioritized list of site-selection criteria below, and an assessment of the *quality of measurements* guidelines outlined below.

The most desirable local surrounding landscape is a relatively large and flat open area with low local vegetation in order that the sky view is unobstructed in all directions except at the lower angles of altitude above the horizon. No significant obstruction within 300 meters of the instrument suite.

There will be many sites that are less than ideal. Selecting a site is a series of compromises between a number of factors. NERON will use the classification scheme below to document the *meteorological measurements representativity* at each site. This scheme, described by Michel Leroy (1998), is being used by Meteo-France to classify their network of approximately 550 stations, as well as by the U.S. Climate Reference Network. The classification ranges from 1 to 5 for each measured parameter. The errors for the different classes are estimated values.

The objective classification scoring scheme follows these general guidelines:

- Temperature and Precipitation elements are given the most weight, in that these are the primary parameters.
- Precipitation is given slightly less weight than temperature since satisfaction of all Class 1 “White” or 2 “Green” temperature criteria is very positive for precipitation as well.
- Angular measurements are used wherever possible. Figure B-1 below shows distance-height ratios.

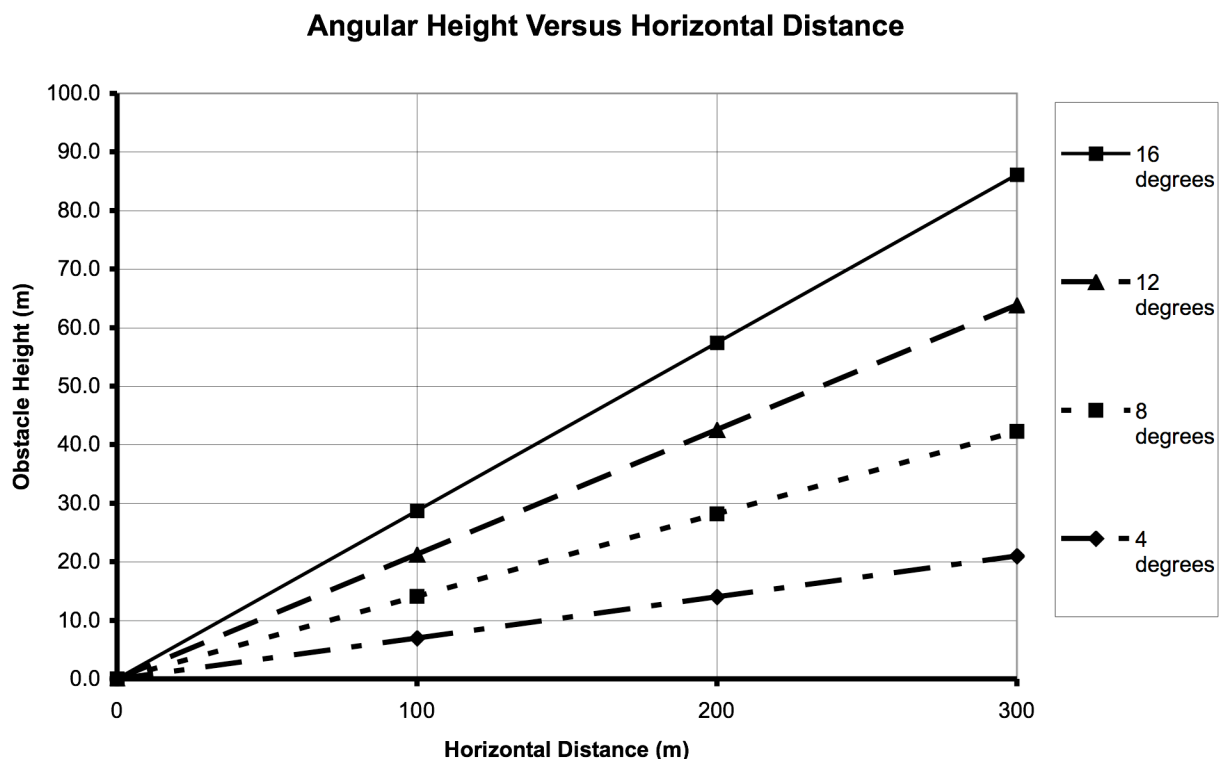


Figure B-1. Angular height versus horizontal distance.

The scores given for the various measured site characteristics are listed in Tables B-1 through B-4 in the following sections, which describe classification for the major parameters that could be measured at any given site.

### B3.1 Classification for Temperature and Humidity

**Class 1 – White:** Flat and horizontal ground surrounded by a clear surface with a slope below  $1/3$  ( $<19$  degrees). Grass/low vegetation ground cover  $< 10$  cm high. Sensors located at least 100 meters (m) from artificial heating or reflecting surfaces, such as buildings, concrete surfaces, and parking lots. Far from large bodies of water, except if it is

representative of the area, and then located at least 100 m away. No shading when the sun elevation > 3 degrees.

**Class 2 – Green:** Same as Class 1 with the following differences. Surrounding Vegetation < 25 cm. No artificial heating sources within 30m. No shading for a sun elevation > 5 degrees.

**Class 3 – Blue:** (error 1°C): Same as Class 2, except no artificial heating sources within 10 m.

**Class 4 – Yellow:** (error ≥ 2°C): Artificial heating sources < 10 m.

**Class 5 – Red:** (error ≥ 5°C): Temperature sensor located next to/above an artificial heating source, such a building, roof top, parking lot, or concrete surface.

Table B-1. Temperature and relative humidity scoring.

Temperature & Humidity Classification / Classification Number	1 (White)		2 (Green)		3 (Blue)		4 (Yellow)		5 (Red)	
Distance from artificial heating sources and reflective surfaces (m)	≥ 300	14 pts	≥ 240 < 300	12 pts	≥ 100 < 240	8 pts	≥ 50 < 100	5 pts	< 50 *	0 pts
Distance to large bodies of water (m) (When location near water is not representative of the area )	≥ 300	12 pts	≥ 240 < 300	9 pts	≥ 100 < 240	7 pts	≥ 50 < 100	5 pts	< 50 *	0 pts
Angular height of surrounding vegetation within 100 m radius (80% or more coverage is below the angle specified)	< 5°	8 pts	> 5° ≤ 6°	6 pts	> 6° < 11°	3 pts	> 11° *	0 pts	*	0 pts
Slope of cleared, flat ground surface within 30 m radius	≤ 8°	6 pts	> 8 ° ≤ 15 °	3 pts	> 15° ≤ 23°	2 pts	> 23° *	0 pts	*	0 pts

## B3.2 Classification for Precipitation

One factor to consider is an area surrounded by uniform obstacles of about the same height. Wind speed is a significant factor that affects the accuracy of measuring liquid and frozen precipitation. A wind shield can be placed around the gauge to improve the accuracy of the “catch.”

**Class 1 – White:** Flat horizontal ground surround by a cleared surface with a slope below 1/3 (< 19 degrees). Any obstacle must be located at a distance of at least 4 times the height of the obstacle. An obstacle is an object seen from the precipitation gauge with an angular width of ≥ 10 degrees.

**Class 2 – Green:** (error 5%): Same as Class 1, except an obstacle is located at a distance of at least two (2) times its height.

**Class 3 – Blue:** (error 10% to 20%): Ground with a slope below 1/2 (< 30 degrees). Any obstacle is located at a distance of at least its height.

**Class 4 – Yellow:** (error > 20%): Ground with a slope > 30 degrees. Obstacles located at a distance less than their height.

**Class 5 – Red:** (error > 50%): Obstacles overhanging the gauge.

Table B-2. Precipitation scoring.

Precipitation Classification / Classification Number	1 (White)		2 (Green)		3 (Blue)		4 (Yellow)		5 (Red)	
Angular height of nearest obstacle with angular width > 10 deg	14°	30 pts	27°	20 pts	45°	10 pts	*	0 pts	*	0 pts

### B3.3 Classification for Wind

Defined for a wind sensor at a height of 10 m.

**Class 1 – White:** Sensor located at a distance of at least ten (10) times the height of the obstacle (elevation angle < 5.7 degrees). Object considered an obstacle if seen at angular width > 10 degrees. Obstacle is below 5.5 m height within a 150 m radius and 7 m within a 300 m radius. Wind sensor located a minimum distance of 15 times the width of thin nearby obstacles (i.e., mast, tree with angular width < 10 degrees). Surrounding terrain relief change  $\leq 5$  m within a 300 m radius.

**Class 2 – Green:** (error 10%): Same as Class 1 except terrain change  $\leq 5$  m within a 100 m radius.

**Class 3 – Blue:** (error 20%): Same as Class 1 except no obstacles within five times the height of the nearby obstacles (elevation angle < 11.3 degrees). Wind sensor located a minimum distance of 10 times the width of thin nearby obstacles. Terrain change  $\leq 1$  m within a 10 m radius.

**Class 4 – Yellow:** (error 30%): Same as Class 3 except no obstacles within 2.5 times the height of the nearby obstacles (elevation angle < 21.8 degrees).

**Class 5 – Red:** (error > 40%): Obstacles within 2.5 times the height of the nearby obstacles.

Table B-3. Wind scoring.

Wind Classification / Classification Number	1 (White)		2 (Green)		3 (Blue)		4 (Yellow)		5 (Red)	
Angular height of nearest “significant” obstacle (angular width >10°)	$\leq 6^\circ$	7 pts	$> 6^\circ$ $\leq 8^\circ$	4 pts	$> 8^\circ$ $\leq 11^\circ$	2 pts	$> 11^\circ$ *	0 pts	*	0 pts
Angular width of nearest “thin” obstacle (angular width <10 deg.)	4°	4 pts	5°	3 pts	6°	1 pt	$> 6^\circ$	0 pts	*	0 pts
Surrounding terrain greatest relief change (angular change)	$< 1^\circ$	4 pts	$\geq 1^\circ$ $< 3^\circ$	3 pts	$\geq 3^\circ$ $< 6^\circ$	2 pts	$\geq 6^\circ$	1 pts	*	0 pts

## B3.4 Classification for Soil Moisture and Soil Temperature

Table B-4. Soil moisture and soil temperature scoring.

Soil Temp/Moisture Classification / Classification Number	1 (White)		2 (Green)		3 (Blue)		4 (Yellow)		5 (Red)	
Slope of cleared, flat ground surface within 30 m radius	$\leq 8^\circ$	5 pts	$> 8^\circ$ $\leq 15^\circ$	4 pts	$> 15^\circ$ $\leq 23^\circ$	2 pts	$> 23^\circ$ *	1 pt	*	0 pts
Basic soil characteristics within 100 m radius	Deep top soil	6 pts	Shallow top soil	5 pts	---	---	A few rocks	1 pt	Rocky ground	0 pts
Ground vegetative cover within 100 m radius	Fully thatched (0% ground bare)	4 pts	Thick vegetation (< 25% ground bare)	3 pts	Moderate vegetation (>25% and <50% ground)	2 pts	Sparse vegetation (> 50% ground bare)	1 pt	Ground Bare	0 pts

## B3.5 Final Site Classification

A final objective class is assigned to each site, given the individual scores calculated for each of the parameters listed in the sections above, as described in Table B-5 below. Then final classifications are assigned for each parameter and for the site as a whole, based on both the objective scores and other subjective analysis collected through site photographs and the information discussed earlier in this appendix.

Table B-5. Objective class score table.

CLASS	TEMP/RH POINTS	PRECIP POINTS	WIND POINTS	SOIL TEMP/ SOIL MOISTURE POINTS	TOTAL POINTS
<b>WHITE (1)</b>	35-40 POINTS	25-30	13-15	13-15	85-100
<b>GREEN (2)</b>	30-34 POINTS	20-24	10-12	8-12	65-84
<b>BLUE (3)</b>	20-29 POINTS	10-19	5-9	5-7	40-64
<b>YELLOW (4)</b>	10-19 POINTS	UNACCEPTABLE	1-4	UNACCEPTABLE	11-39
<b>RED (5)</b>	UNACCEPTABLE	UNACCEPTABLE	UNACCEPTABLE	UNACCEPTABLE	0-10